

***Fields*: An Exploration into the use of Mobile Devices as a Medium for Sound Diffusion**

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ABSTRACT

In this paper we present *Fields*, a sound diffusion performance implemented with web technologies that run on the mobile devices of audience members. Both a technical system and bespoke composition, *Fields* allows for a range of sonic diffusions to occur, and therefore has the potential to open up new paradigms for spatialised music and media performances. The project introduces how handheld technology used as a collective array of speakers controlled live by a centralized performer can create alternative types of participation within musical performance. *Fields* not only offers a new technological approach to sound diffusion, it also provides an alternative way for audiences to participate in live events, and opens up unique forms of engagement within sonic media contexts.

Author Keywords

Sound Diffusion, Network Performance, Performance, Artistic Research.

1. INTRODUCTION

Fields is a networked system exploring new areas of musical performance and spatialised sound through the use of personal mobile technology as a medium for sound diffusion. Personal mobile technology in this context includes smart phones, tablets and laptops as well as other portable devices that can run a web browser. This project provides an alternative method for sound diffusion as well as offering new ways in which audiences can engage in media works. The project *Fields* refers to two main, interconnecting parts:

- An audio playback system using web technologies to diffuse sound live through the inbuilt speakers of the audience's mobile devices.
- A specially designed composition and performance demonstrated through the system presenting this approach to sound diffusion.

Fields has been publicly performed numerous times to international audiences in the UK, Germany, France, Finland, Portugal and Greece.

By building the system alongside an accompanied bespoke composition we allowed the technical arrangement and sound design to be directly informed by each other. In doing this we could explore and exploit the technological potentials of the system through the development of a specially constructed composition. This approach also enabled us to professionally present the performance as a new musical piece gaining us practical experience in a genuine artistic setting. All of the authors of this paper have professional experience working as musicians, sound artists and performers (see [2]). This experience directly informed the technical design of *Fields* as well as the aesthetic decisions made during the design and performance process. It is important to note our artist-led

approach. The desire to compose a piece for the system was equal to the desire of building the system itself, to us both elements are as important as each other.

1.1 Motivation

There are multiple motives to why we decided to build and perform using a system that adopts personal mobile technology. We describe three below.

Participation – Contemporary concerts can involve people filming, taking pictures or reporting on their experience using social-media smartphone applications. By using the phone as a performance-instrument, we momentarily create an alternative relationship with this technology during a musical performance. As many portable devices are handheld, this performance also opens up alternative ways in which people can participate in a musical performance. With audience members holding their own personal speaker each can contribute their sound to the overall composition.

The Sonic Results – Hearing a concert diffused through many small speakers held in the hands of the audience, is a unique experience. By having the speakers distributed throughout the audience we create a multi-directional, textured sonic environment. Rather than an even spread of sound, found in a 'normal' concert setting, *Fields* creates small 'pockets' of sound throughout the audience. This results in both an unusual sonic output as well as an interesting performer-audience dynamic.

Using What's Available – Aside from the social aspects and unique sonic properties of this system, *Fields* also offers a number of practical advantages for sound diffusion. Traditional forms of electronic spatialised sound require large amounts of equipment and set up time. *Fields* does not require this; once a network has been established participants can turn up, connect and listen. This allows performances to take place within novel and unique environments, giving the piece site flexibility. *Fields* does not require the user to download a specially made application, nor do we need to hand out specially designed speakers. Contemporary smart phones provide us with ample technology to achieve *Fields*. By using only web technologies, we allow for the system to be commonly supported on many devices, creating a low threshold for participation.

1.2 Related Work

Fields is not the first project to make use of technologically supported, shared spatial sound environments. Some previous examples of work which involve similar themes include the following:

Contact [3] a performance piece by Ollie Bown, which was performed at the New Interfaces for Musical Expression (NIME) conference in 2014. The piece required audience members to physically pass a number of portable, orb-shaped, wireless speakers through the concert hall. This provided a 'tactile acoustic experience' allowing participants to physically

engage with the sonic work. Passing the speakers through the audience enhanced a collective, shared experience. With each pass participants were providing spatialised structure to the composition.

Contact provides an example of researchers using new technology to reinforce the shared nature of music, providing a tactile experience alongside a sonic one. *Fields*, as both a system and composition, builds upon this previous work. In our research we present not only a study of a technological system but also how it socially engages the audiences we have performed it to.

Another related piece, Atau Tanaka's *Global String* [7] takes the form of a giant, international, stringed instrument. He uses a global networked connection as a 'resonant body', allowing two different sites to communicate through a suspended string. Tanaka has described creatively embellishing technical limitations such as latency, as 'creative material'. This consideration of technical issues ties in with our approach to the sound design of *Fields* where we used the network latency as artistic material rather than a restriction (this point is expanded later in this paper). Both *Contact* and *Global String* provide examples of artistic interests in approaching spatialised sound work that *Fields* builds upon.



Figure 1 A performance of *Fields* at the Talbot Rice Gallery in Edinburgh (Image: Chris Scott)

1.3 A Typical *Fields* Performance

During a performance of *Fields* any audience member can join the piece, at any time, by simply using their smartphone, laptop or tablet to connect to a centralized Wi-Fi network configured by the performer. Once connected, participants are asked to enter a URL in a web browser which will take them to a specially designed webpage. The webpage displays a simple map of the performance space, and requests the user to locate themselves in the space with a simple touch. Once the location has been selected, a connection is established with the server and sonic and visual feedback is immediately apparent. The connected devices become part of an array of speakers which the performers can then control live. The result, provided a number of devices are connected, is an omnidirectional, multi-locational sonic output, with each connection individually contributing to the overall composition. The connected devices create a spread of sound across the environment, with the sound diffusion being directly informed by each audience member's location. Each participant with a connected device becomes a node in a musical network. Each new connection interjects the sonic space. Though *Fields* is a versatile system, one which can be used in many different configurations, we have generally performed the piece using a quadrophonic sound system alongside the audience's devices. The structure of the composition provides an interplay between the quadrophonic system and the device system. For example many portable devices cannot play low frequencies so the low-end is delivered by the 'regular', 4-channel system.

2. DESIGN PROCESS

Our approach to the design of *Fields* was in keeping with Frayling's *research through art and design* [4] an approach to creative work that has become known in HCI particularly through the work of Gaver and his colleagues and extended by Bowers [1] amongst others. This approach has been demonstrated throughout the design of *Fields*. Working within the style of electro-acoustic music we engaged directly with sonic material and built the piece using the sound as our source material, rather than a preconceived tonal or harmonic system. Furthermore our appropriation of mobile technology allowed us to creatively 'customise' our own sound system.

In parallel but independently of the notion of research through art and design, anthropologist Tim Ingold articulates *thinking through making*, an opposition to the 'traditional' *making through thinking* to express the importance of research and knowledge creation through a physical engagement with materials [6]. We allowed our engagement with sonic and technological materials to remain flexible and adaptable throughout the making of *Fields*. By approaching this project through Ingold's concepts we deliberately avoided thinking in terms of a problem-solution scenario, an approach more familiar in 'traditional' forms of research. Our research remained fluid and changeable throughout the project.

We conducted various experiments to test for latency between triggering the sound and it occurring on the device. There was a huge variation between devices depending on their age, operating system and how far away they were from the router. As we had little control over the type of devices people would bring to the performances, it was decided to implement sound design that would embellish the latency – comparable to Tanaka's use of latency as 'artistic material' in *Global String*. For example, instead of a perfect synchronization between devices, certain sounds would create a 'shimmering' across the room, with the slight differences actually creating an interesting spatial diffusion. Historically, literature on networked sound projects focus on the technological pitfalls such as latency or audio quality (expanded on here [5]). In this project we embellished it, using it creatively and to our advantage.

2.1 Sound Design

The Sound Design for *Fields* was developed in various stages and has been revisited numerous times following performances. Various considerations had to be made to incorporate the characteristics of the phone speakers, the various degrees of latency and the spatial nature of the piece. Though the performance of *Fields* has a degree of performative flexibility, a typical presentation is described as follows. The piece starts with a soft drone fluctuating between each of the 4 channels of the main system, simultaneously a layer of white noise and field recordings of water droplets, processed through a granular synthesizer, play from the connected phones. At this point, there are usually audience members still connecting, as each device connects a new sound source inserts into the sonic space. The water droplets and white noise create a dense texture, complemented with the soft drone. This compositional method creates an interplay between the parts without them interfering or masking each other. A loud gestural anacrusis from the large speakers marks the beginning of the second section and the phones are left bare without support from the main system. Field recordings of cowbells (from actual cows, rather than the 'instrument'), again processed through a granular synthesizer, slowly emerge from the phones giving the piece a tonal quality. As these become more present the 4-channel system plays back a more complex granular version of the same sound files. Each speaker is assigned a different grain with varying parameters giving a strong spatial quality to the

surround system. The textures build, creating more ambiguity between the web system and the main system. A low-mid drone emerges from the main system as bursts of tuned descending sine and saw tooth waves appear from the phones. A percussive sound from the handheld speakers creates a subtle rhythmic element to the composition. This is supported by a very low-end kick drum which plays a poly-rhythmic sequence from the 4-channel system. Elements of the piece are slowly taken away leaving a percussive structure with a bed of white noise, a combination of a noise generator and field recordings of the sea, again through a granulator. The loud gestural sound reappears and marks the end of the piece, giving the piece a clear cadence. During some performances of *Fields* phones can go to sleep and stop receiving commands from our server, this can result in phones continuing after this last cadence. This creates interesting results but the gestures allows a clear ending for the piece so audiences with unresponsive phones can either fade out or turn off the sound for their device.

2.3 Technical Design

Fields is implemented using mainly web technologies. A web server is exposed to participants via a wireless network. The system consists of three main parts.

- **The audience web page:** Loaded on the devices by the audience members, this page contains a variety of audio playback ‘instruments’ (sample player, looper and granulator) implemented using JavaScript and Web Audio API. The page doesn’t offer any control on those instruments, and from the point of view of the audience, this page just plays sounds.
- **The control panel web page:** This allows the performers to control in real-time the instruments loaded on the devices. There is a separate panel for each instrument, and each panel offers a number of parameters for that instrument as well as room panning control. Each instrument is implemented with a number of controls, which, at its simplest, is an on/off button and a volume control. More complex instrument controls made use of buttons, sliders, XY axis and envelope drawers.
- **The server:** The centralised network, which serves the two web pages as described above, handles the communication between the instruments and the performers controls. (See Fig. 2)

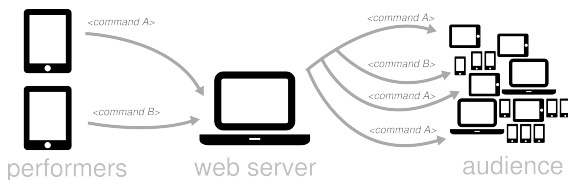


Figure 2 Communication Flow for *Fields*

2.2 Technologies Used

The JavaScript programming language is used throughout the system. The functionalities needed in the server are general enough that it was decided to package them into a standalone library called *Rhizome*¹ which is an ‘out-of-the-box’ solution for OSC to WebSocket communication built by the second author of this paper. *Rhizome* does the heavy-lifting and handles all the networking issues like disconnections and sending of large packets of data.

¹ <https://github.com/sebpiq/rhizome>

2.4 THE INSTRUMENTS

One sound generation method used in the system of *Fields* involved the playback of pre-recorded sounds on users’ phones in a variety of ways, techniques including looping, sequencing and granular synthesis. These playback methods had to consider the limitation of how much data could be loaded onto the webpage. We implemented a number of techniques to enable us to playback these files in a variety of ways.

Triggering Sounds was quickly implemented to playback files from start to finish in a simple ‘press play’ manner. This method was stable but lacked performativity; we decided to apply this alongside some other approaches.

Granular Synthesis was implemented to playback audio with various starting points and using a variety of different sized ‘grains’. With these techniques we could playback the loaded files with more versatility, giving us further performativity. We could playback these grains *in unison*, with all phones reacting at roughly the same time, or, which proved very productive, *in combination* at different randomised times. This yielded extremely positive results, playing back different parts of the same sound file across a room full of mobile devices gave a very good sense of spatialised composition. Due to particular implementations, every connected node has the potential to play *in unison* or *in combination* with other devices; the performers can make this decision in real time. *In Unison* - when all of the connected devices are playing the same sound at roughly the same time (small amounts of latency do, often desirably, occur). *In Combination* when each device is playing a different sound, combined with the other sounds to create the overall composition. Through this we create moments of *collective conjunctions* alongside spatial discrepancies (or *sonic shimmerings*).

Two **Sequencing** tools were developed for the project to playback various pre-recorded files. Designing a sequencer for this system had to take into account a big limitation; it is almost impossible to synchronize all devices together and having them played with a common timing. Therefore, considering this limitation we designed two different sequencers. The first is a centralized sequencer running on the control page. For each event in the sequence, a message is sent, triggering a sound on the devices. Due to latency, each device receives the message at a different time. Therefore all sounds are triggered at slightly different times. But as there is only one central sequencer, sounds are always synchronized on an absolute tempo but not in relation with each other. The second sequencer runs on each individual device. The sequence is sent from the control page, but the devices handle the timing. Each device plays the same sequence, but the sequences have slightly different start times. Therefore all devices are synchronized in relation with each other, but not to an absolute tempo.

A number of simple **Synthesis** engines were implemented to give some flexibility away from the pre-recorded sound. The performer can control the pitch, volume and FM and AM modulation of a simple sawtooth and sine oscillator as well as white noise generator. By building a graphical envelope automatic pitch and volume changes could be drawn in, resulting in smoother changes than if done by hand.

3. DISCUSSION

3.1 Embracing the Creative

By staying flexible throughout the design process, we were able to creatively and artistically embellished aspects such as latency, sound design and audience configurations. These aspects of the process could have been considered as technological downfalls. Instead we productively integrated such discrepancies into the design space of the project. By

adopting a *thinking through making* approach we allow technological and sound design aspects to become artistic material which we crafted *Fields* from.

3.2 The Aesthetics of *Fields*

We have already remarked how important it was for us to co-develop *Fields* as both a composition and a technical system. This point about the co-dependency of different features of design can be extended further. Effective performances of *Fields* also involve attention to creating an arena for attentiveness through arranging the audience in a particular way and unfolding the composition so as to focus people's attention and expectations while giving latitude for experimentation. Through varied phone performance in a focused arena for attentiveness, the audience is able to co-create a subtly complex and layered listening environment alongside the performers. The arena of attentiveness becomes an arena for experimentation. We would wish to argue that all of *these features together create a characteristic aesthetic experience for Fields*. Our successful performances involve not just working technology or artful performance of composed material but of all that, together, in a carefully configured environment.



Figure 3 Audience Members at a Performance of *Fields*

3.3 Re-Configuring Mobile Design

There exist many examples of musical applications developed for mobile devices. *Fields* involves a reconceptualisation of designing for the mobile device. Rather than assigning exclusive focus to *what is inside the device*, we are concerned with *what the device is within*. This includes how audiences engage together around their devices in performances, how they share a sonic social experience, how they interact with their device whilst contributing to the overall composition.

3.4 Public and the Personal

A mobile phone is typically thought of as a very personal device, holding information such as private text messages and emails as well as private security data. Does *Fields*, momentarily change the role of the mobile phone? We are using a potentially private device to create a collective, public, temporal performance. This opens up an interesting public-personal space of exploration. While this was not an original intent for the work, this theme emerged through the numerous public performances and presentations of the piece, and our analyses of video material.

With these analytical observations in mind, *Fields* creates multiple forms of engagement in the context of a musical performance. By using handheld devices to diffuse sound each member of the audience holds an individual part of the composition but contributes to the over all group experience. By pulling focus from what is within the device and moving to a perspective that settles on what the device is within we provide a rich collective experience and hope to enrich *the social through the sonic*.

4. CONCLUSION

We have described here a technological method for sound diffusion presented within a live performance setting. Through adopting an artist-led approach we allowed the project to change and remain fluid throughout the design process and for the composition and technical system to inform and influence each other. An openness to such changes let creative elements emerge from unexpected occurrences, latency and sound design issues. This paper also articulates various unexpected issues which arose during the development of this project such as the complex interplays which we observed between musical structure and listening experience, and the range of personal phone performances.

By presenting *Fields* numerous times in genuine artistic settings to various audiences we discovered that this project is much more than just a technical system. *Fields* provides a new, rich social context for musical performance in the relationship between the phone in the hand and the 4-channel system, in how audience and performer engage each other, and in sound design for tiny speakers. It enhances one's spatial awareness of/in the environment and the relationship between oneself and others.

As performances for mobile devices are becoming more commonplace we hope that our findings with *Fields* adds a research contribution to the NIME community and for individuals who are interested in performing with such a system and studying the social implementations of such presentations. The basic system for *Fields* is available as an open source project via Github. As development continues into the future we plan to continue to publish with the hope to make a user friendly, modular system available for musicians to use. *Fields* allows for performers to extend the sound system, to branch forward into the audience and to break the fourth wall of the performance space. *Fields* manifests an extended sense for what we can expect of a mobile device. Mobile phones can go beyond being personal or private listening devices and support complexly layered dynamic listening environments in which performers and audience members can experiment and co-create new collective listening experiences.

5. ACKNOWLEDGMENTS

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